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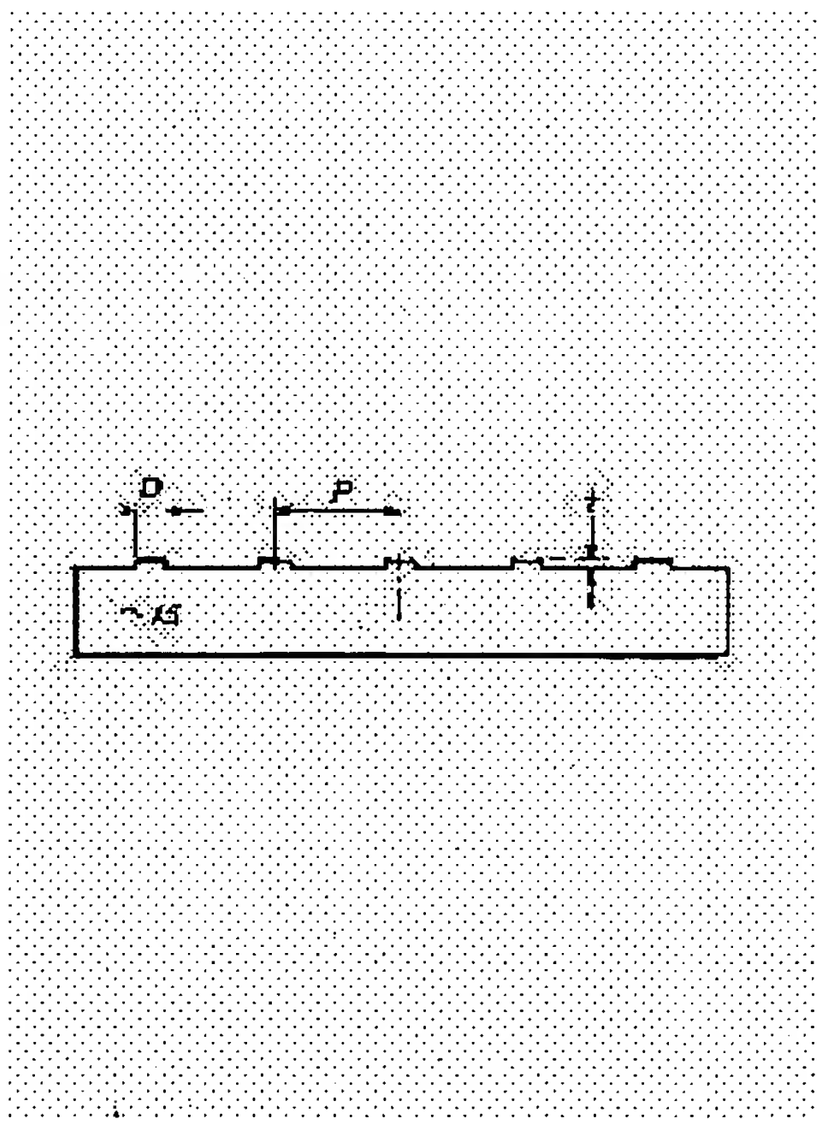
(54) STEEL SHEET EXCELLENT IN IMAGE CLARITY OF COATING AND PRESS-WORKABILITY

(57)Abstract:

PURPOSE: To provide a steel sheet excellent in image clarity of coating and press-workability.

CONSTITUTION: This steel sheet is a steel sheet having different kind of profile on the surface and back faces on which projecting parts are discrete/scattered so that the mean area rate of recessed parts oh the other side is smaller than that on one side by taking the size of the top face of projecting parts which are scattered on both surface and back face of the steel sheet as 10-1000μm, the distance between peaks of projecting parts as 50-2200μm, the roughness Ra of recessed parts on the one side of the steel sheet as ≤0.8μm, the height of the top face of projecting parts which are scattered on the one side of the steel sheet as 2-12μm making the height of projecting parts on the other side higher than that on the one side in the range of 3-20μm and taking the mean area rate of recessed parts on the one side of the steel sheet as 70-96 %. In this way, press-workability is improved and also the degradation of the image clarity of coating after working is surely prevented.



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CLAIMS

[Claim(s)]
[Claim 1] The magnitude of the heights top face which are scattered to front flesh-side both sides of a steel plate 10-1000 micrometers, The roughness Ra of the crevice by the side of 50-2200 micrometers and one side of a steel plate sets [the distance between peaks of heights] to 0.8 micrometers or less. On the other hand, the height of the heights top-most vertices which are scattered in a steel plate one side side makes 2-12 micrometers higher than an one side side in the range whose near heights height is 3-20 micrometers. And the steel plate excellent in the paint image clarity characterized by for the rate of crevice average area by the side of steel plate one side considering as 70 - 96%, and carrying out discrete distribution of the heights so that the near rate of crevice average area may become small from an one side side on the other hand, and press workability.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the steel plates excellent in the image clarity used for an automobile, the shell plate of home electronics, etc., and press workability. Steel plates mean the tabular product painted and used here, for example, a stainless steel plate, an aluminum plate, a copper plate, etc. are included other than steel plates, such as hot rolled sheet steel, cold rolled sheet steel, and surface treated steel sheets (an electroplating steel plate, a hot-dipping steel plate, an alloying processing hot-dipping steel plate, a vacuum evaporationo plating steel plate, molten salt electrolysis plating steel plate, etc.).
[0002]
[Description of the Prior Art] Generally, although the steel plate used for the body of an automobile, the shell plate of home electronics, etc. is used as a product by performing press forming, with highly-precise-izing and complication of a product, the demand to steel plates is being upgraded and diversified more than before, and the demand about paint image clarity and press-forming nature is increasing especially recently. For example, although it is certainly improvable by thickening paint thickness in order to raise the image clarity of the product itself, there is a problem to which paint costs become high. For this reason, even if paint thickness is thin, a steel plate which can secure paint image clarity is desired strongly. Moreover, although paint and 4 times paint are performed 3 times in the present condition in order to secure paint image clarity, to omit the number of coats to 2 or 3 times for process saving and paint costs reduction is desired strongly, and a steel plate which can realize this is desired strongly. In order to meet such a demand, minute irregularity is prepared in a reduction roll using laser like JP,63-132701,A, steel plates are rolled out using the reduction roll, and obtaining the steel plate excellent in paint image clarity is known.
[0003]
[Problem(s) to be Solved by the Invention] In order to raise paint image clarity, the front face of a steel plate is flat, and it is so advantageous that it is close to a mirror plane. For this reason, various proposals are made towards making a front face fine. However, that it is easy to actualize a crack in a heat treatment process or a plating process in the production process of steel plates, if it only mirror-plane-izes, since a surface crack occurs at the time of piling after cutting of steel plates, or press working of sheet metal and it becomes surface discontinuity, various devices are proposed again. By the way, although press working of sheet metal will be the requisite in case a product is manufactured, there is a problem which grinding stone credit may be carried out in this case for the surface appearance improvement after processing, and for this reason looms after a grinding stone credit pattern's painting. Moreover, since steel plate roughness changes with press working of sheet metal, there is a problem on which image clarity deteriorates, so that workability becomes severe. For this reason, a steel plate which can maintain paint image clarity even with after [good] processing is desired strongly.
[0004] Two kinds are one of the causes of degradation of the paint image clarity by processing. That is, when it originates in roughness changing and surging owing to the ununiformity of deformation, and a

component increasing, when the grain size number of a material is large and paint image clarity deteriorates, in order that another may loom in the one side side in contact with punch whose near roughness is the opposite side by high planar pressure on the other hand, the paint image clarity by the side of one side may deteriorate. make it any -- since high image clarity is required recently, a small thing of degradation of the paint image clarity after such processing is desired strongly.
[0005] Moreover, recently, since press working of sheet metal of the components of a complicated configuration is carried out, it is desired for the sliding nature at the time of shaping to be good. Under high planar pressure, since a dice and a plating layer tend to agglutinate and frictional resistance increases, surface treated steel sheets, such as a galvanized steel sheet and an alloying processing hot-dip zinc-coated carbon steel sheet, especially have the problem that the shaping fitness range is narrow that it is easy to carry out plate fracture at the time of shaping. This invention tends to offer the steel plates which improve the sliding property at the time of press forming, and can secure the image clarity reservation even with after [good] press working of sheet metal in order to respond to the quality technical problem required of an image clarity steel plate which was mentioned above exactly.
[0006]
[Means for Solving the Problem] In front flesh-side both sides of a steel plate, the magnitude of a scattered heights top face this invention 10-1000 micrometers, The roughness Ra of 50-2200 micrometers and a crevice 0.8 micrometers or less, [the distance between heights peaks] The high bulk of heights top-most vertices which heights are made to carry out discrete distribution so that the rate of average area of the crevice by the side of steel plate one side may become [the rate of average area of the crevice by the side of a field besides a steel plate] smaller than an one side side 70 to 96%, and is scattered in a steel plate one side side and by the range of 2-12 micrometers The steel plate excellent in the paint image clarity to which the heights height by the side of a field besides a steel plate is characterized by making it higher than an one side side in the range which is 3-20 micrometers, and press workability is offered. That is, this invention is giving a roughness profile which is different on the front reverse side, and after press forming is characterized by securing good paint image clarity at the same time it improves the sliding nature at the time of press forming.
[0007] The gestalt of the roughness profile of this invention is explained to a detail below. constituting the roughness profile which consists of a flat crevice which occupies most steel plate front faces, and very small heights which are discretely scattered the optimal found out that it was certainly improvable importantly so that we maintained good paint image clarity before and after processing, and it might state below, as a result of examining many things about the conditions of the roughness profile for boiling press-forming nature markedly and improving.
[0008] Since press-forming nature especially severe recently was required, much more moldability improvement was desired, and this invention was reached as a result of examining the structure on the optimal front face of a steel plate where both paint image clarity and press workability can be improved. If it is not processed, it is satisfactory, but when it is processed, with the conventional technique, there is a problem on which paint image clarity deteriorates. In order to secure paint image clarity even with after [good] press working of sheet metal, it found out that it was solvable by making higher than the heights height by the side of one side used as external surface the height of the heights of the other sides which become an inside side in the front flesh side of a steel plate at the time of press forming, and making the rate of crevice average area by the side of one side into 70 - 96%, and on the other hand making the near rate of crevice average area smaller than an one side side.
[0009] Next, it supposes the main point of this invention that sequential explanation is given about a side on the other hand a steel plate one side side, and, first of all, it is described about an one side side. In the one side side of a steel plate, since it becomes people's eyes the external surface side touched directly when it becomes a product, paint image clarity serves as important quality also in the result nature of paint. Paint image clarity is related to the roughness and the rate of area of a steel plate crevice. Therefore, although it is desirable as roughness of a crevice that it is flat as much as possible, and close to a mirror plane, for manufacturing advantageously industrially, if it is 0.8 micrometers or less in Ra, paint image clarity can be secured enough, and it may be satisfied. Moreover, although the rate of area

of a crevice is so advantageous to the improvement in paint image clarity that it is high, it is desirable for the rate of crevice area to secure in the range 70 to 96%. If the rate of crevice area is smaller than 70%, even if it will improve the roughness of a crevice, it becomes difficult to secure image clarity. Moreover, if conversely larger than 96%, although image clarity is good, since ****-proof and the sliding nature at the time of a press deteriorate, it is not desirable. On the other hand, even if it is smaller than 70%, since the paint image clarity after processing deteriorates even if it is larger than 96%, the above-mentioned range is the optimal [image clarity].

[0010] On the other hand, it is necessary to set magnitude of a heights crowning to 10-1000 micrometers, and the heights height by the side of steel plate one side used as the external surface of shaping components needs to set it to 2-12 micrometers about the gestalt of heights. Although being easily crushed by the punch load decreases when the magnitude of heights was smaller than 10 micrometers and it fabricates, the contact surface moment with punch increases and sliding nature deteriorates. Moreover, in a processing process or a conveyance process, there is a problem the problem on which an abrasion becomes easy to be conspicuous is shown in a steel plate front face or a paint film front face upwards, and it becomes impossible to secure good paint image clarity.

[0011] Moreover, in that sliding nature deteriorates since it will be easily crushed about the height of heights at the time of shaping if lower than 2 micrometers, and a processing process and a conveyance process, since an abrasion becomes easy to be attached, the function needed for heights is no longer demonstrated. Conversely, although sliding nature and abrasion nature will improve if it is made higher than 12 micrometers, the problem on which heights float and appear after paint and paint image clarity deteriorates arises.

[0012] Next, the main point of this invention is explained about a field [besides the steel plate with which punch contacts] side at the time of processing. paint image clarity since it becomes the inside side of the product of a steel plate which a side does not have in people's eyes direct deflection on the other hand -- ** -- it is important not important quality but that it can control that maintain sliding nature with the punch at the time of processing good rather, and the paint image clarity by the side of one side after processing deteriorates as much as possible. After controlling crushing of heights under high planar pressure as mentioned above in order to have secured sliding nature, it is important to make the contact surface moment with a dice small as much as possible. For this reason, it is desirable to enlarge the height of heights in the condition range which does not degrade other quality, and to rationalize the rate of area of heights. The heights height by the side of a field besides the steel plate which serves as an inside of shaping components from this viewpoint as a result of examining many things is making it higher than an one side side in 3-20 micrometers, and making the rate of crevice area smaller than an one side side, and it became clear that the operation needed for a side on the other hand could be demonstrated.

[0013] When it explains in more detail, on the other hand, the magnitude of the crowning of near heights has desirable 10-1000 micrometers by the same reason as the one side side mentioned above. On the other hand, since heights will be crushed easily, and there will be no sliding nature improvement operation and the wave of a field besides a steel plate will be imprinted at an one side side from two points, an operation on a sliding disposition, and the operation which controls degradation of the image clarity by the side of one side by processing, if 3-20 micrometers is desirable and lower than 3 micrometers, the height of heights has the problem on which the paint image clarity by the side of one side deteriorates. Conversely, if higher than 20 micrometers, although sliding nature is held sufficiently good, since the pattern of the heights of other sides is imprinted after processing at the one side side which is an opposite side, it makes the paint image clarity by the side of one side deteriorate, and is not desirable.

[0014] Next, it states to a detail from a viewpoint of paint image clarity degradation by processing. Various rollings, such as hot rolling, cold rolling, and temper rolling, are obtained, and, usually board thickness control, quality-of-the-material control, and configuration control are performed. For this reason, since the roughness profile with various rolls is imprinted by the steel plate front face, the external waviness component of the roughness of various wavelength exists. Removing this external

waviness component has the problem by which various difficulties are accompanied upwards industrially and which cannot be solved by the approach cheap in cost.
[0015] It is based on the following two reasons that image clarity deteriorates by press working of sheet metal. The thing resulting from originating in the micro heterogeneous deformation of an ingredient in that case, and a "wave" increasing, although base crystal grain will deform and run if one processes a steel plate, and another originate in a "wave" increasing, when roughness on the back is imprinted by the opposite side at the time of extruding by punch. That is, if it is carried out under high pressure from a side on the other hand with the punch which has a smooth front face when press forming of the latter example is carried out, on the other hand, a near external waviness component will be extruded at an one side side, the external waviness component of the roughness by the side of one side will increase, and paint image clarity will deteriorate. make it any -- here, suppose that these problems are called "increase of the wave by processing."
[0016] We found out that "increase of the wave by processing" was avoidable by the thing in contact with punch for which near heights are made high on the other hand, and the near rate of crevice area is made smaller than an one side side on the other hand, as a result of examining many things about the solution approach of these problems. Since it has the effectiveness that these heights reduce the micro true contact surface moment with punch or a dice to coincidence, the frictional resistance in high planar pressure decreases, the sliding nature at the time of press forming is improved, and there is an advantageous point which the shaping fitness range expands. Moreover, since sliding nature is improved and the homogeneous deformation nature of an ingredient improves, there is an operation in which the trouble resulting from the crystal grain of a material is also improved.
[0017] In order to avoid this problem, the rate of heights area can be raised or it can consider making the magnitude of the top face of heights increase etc., but it is not effective in order for all to raise a sliding friction, or for there to be no prevention effectiveness of "increase of the wave by processing" or to make it deteriorate conversely. It is making the heights height by the side of a field besides the steel plate which becomes the inside side of shaping components higher than an one side side in the 3-20 micrometer range, and, making the near rate of crevice area smaller than an one side side on the other hand, after the one side side of a steel plate considers as this invention range, as a result of our examining many things, and it found out that there was an operation which can control degradation of the paint image clarity by "increase of the wave by processing." The reason is explained below.
[0018] On the other hand, paint image clarity is important for a side in order [of a steel plate] to control not a problem but degradation of image clarity according rather to the roughness change after reservation of the sliding nature at the time of shaping, and press working of sheet metal. That is, at the time of press forming, in a PIDO part or a blank holder part, in order to receive processing accompanied by sliding under high planar pressure, the frictional resistance on a dice and the front face of a steel plate increases, and there is a problem to which sliding nature deteriorates or a plating layer exfoliates in the case of a surface treated steel sheet. It is important to reduce the micro rate of contact surface area on a dice and the front face of a steel plate, in order to avoid this problem, and in order to secure sliding nature in the bottom condition of high pressure, it is desirable to set heights height to 20 micrometers or less by 3 micrometers or more, and to, make the near rate of crevice area smaller than an one side side on the other hand.
[0019] That is, although it is important to secure the rate of crevice area to 70 - 96% since paint image clarity is important for an one side side, on the other hand, it is important for a side to hold a good property rather at the time of processing. That is, it is important for the property required of a side on the other hand at the time of shaping that near heights cannot be crushed easily on the other hand. If near heights are easily crushed at the time of shaping, since the true contact surface moment of punch and a steel plate will, on the other hand, increase two problems (one [i.e.,]), on the other hand, near roughness becomes that it is easy to imprint at the one side side which is an opposite side, the wave by the side of one side increases, and sliding nature's deteriorating and another have the problem of paint image clarity deteriorating.
[0020] Thus, on the other hand, a function required for a side is to reduce degradation of the paint image

clarity by the side of good sliding nature reservation and one side with the punch at the time of processing as much as possible. Thus, this invention was reached as a result of examining the functional assignment in a steel plate table flesh side from various viewpoints. In order for the heights by the side of a field besides a steel plate to make it hard to be crushed at the time of shaping, it is necessary to make high the height of making planar pressure concerning one heights small, and heights as much as possible. In order to make near heights higher than an one side side in the 3-20-micrometer range on the other hand and to secure the rate of heights area for such a reason, the operation needed for a side on the other hand can be demonstrated by making the rate of crevice area smaller than an one side side. Moreover, this invention which has such a roughness profile has the effectiveness which also mitigates degradation of the paint image clarity by the micro heterogeneous deformation resulting from deformation of the crystal grain of a steel plate base, and has an advantageous operation.

[0021] By the way, in order to bear the high planar pressure by the dice punch at the time of processing as arrangement of heights, it is necessary to raise the rate of area as much as possible. Therefore, on the other hand, it is necessary to make the near rate of crevice area smaller than it by the side of one side and, and, as for heights, arranging discretely is desirable at intervals of 50-2200 micrometers. On the other hand, although what is necessary is just to, make the near rate of crevice average area smaller than a side on the other hand, if it is 25 - 90%, for example as a rate of crevice area, it is more desirable. Since the rate of area of heights is too large when smaller than 25%, the contact surface moment with punch increases and sliding nature deteriorates. Moreover, since the rate of area of heights will fall if larger than 90%, when severe shaping is performed, the planar pressure per heights increases, and since it becomes that it is easy to be crushed, the sliding nature improvement operation by heights falls.

[0022] By the way, even if it makes it smaller than 50 micrometers about spacing of arrangement of heights, since the processing cost which gives heights increases to the improvement effect over sliding nature or the roughness imprint nature by processing being saturated, it is not desirable. Moreover, if it is made larger than 2200 micrometers, since there being a problem on which an abrasion's tends to go into a crevice since top spacing's is too large, and the planar pressure which starts one heights at the time of processing will become high, there is a problem on which the pattern of heights becomes easy to loom in the one side side which is an opposite side, and paint image clarity deteriorates. Therefore, top spacing of heights has desirable 50-2200 micrometers, and an operation of this invention can be demonstrated effectively.

[0023] In addition, the rate of crevice area by the side of a field besides a steel plate is described below about other important operations made smaller than an one side side. In order to manufacture the steel plate of this invention cheaply industrially, it is common to prepare a concavo-convex pattern in a roll, to cold-roll with the roll concerned, or to carry out temper rolling, and to imprint and manufacture irregularity, and it is an advantageous and simple approach. In the case of this approach, a steel plate front face will be pressed down by the heights of a roll, and the crevice of a steel plate will be formed. However, when this invention is applied to the temper rolling generally known, from the need of controlling the configuration and quality-of-the-material property of a plate, the steel plate elongation percentage by the draft of a steel plate is regulated to 0.5 - 2.0% in many cases, and since rolling reduction is small, there is a problem on which the heights height of a steel plate decreases with the increment in the rate of area of the crevice of a steel plate.

[0024] This is expressed with a bottom type in [the elongation percentage of the steel plate by the roll draft] approximation.

delta L=delta txS (they are a deltaL:steel plate elongation percentage, a rate of S:crevice average area, and deltat:board thickness average percentage reduction here)

For this reason, since average board thickness percentage reduction:deltat becomes small with the increment in rate of area:S of a steel plate crevice to obtaining predetermined steel plate elongation-percentage:deltaL, it will become small as a result, the level difference, i.e., the heights height, of the small steel plate heights of a draft, and the pressed-down crevice.

[0025] Therefore, in order to make heights height high as much as possible, it is desirable to make the rate of crevice area small. However, on the other hand, since [of a steel plate] a side needs to make the

concave surface moment high with 70 - 96% from a viewpoint of paint image clarity reservation, heights height can be made high by making crevice area by the side of a field besides a steel plate smaller than an one side side. Although the heights by the side of a field and one side besides a steel plate have the operation which becomes high so that the rate of crevice area by the side of a field besides a steel plate is small, it is 25 - 90%, and the rate of crevice area by the side of a field besides a steel plate is making it smaller than an one side side, as mentioned above, and the steel plate of this invention is obtained.
[0026] As stated above, the rate of crevice area by the side of a field besides a steel plate by making it smaller than an one side side By optimizing on the conditions which are made to carry out the functional assignment of a roughness profile on that it can deal in the heights height of this invention certainly, and the front reverse side of a steel plate, and are needed for each field It is the description of this invention that an operation (reservation of the paint image clarity on a sliding disposition and in processing order) of this invention can be demonstrated certainly.
[0027] This invention was reached as a result of examining a roughness profile fundamentally from various viewpoints for the purpose of attaining the functional assignment of a steel plate table flesh side, and optimization, as mentioned above. That is, after processing can maintain the paint image clarity by the side of one side good according to two operations, control [, controlling the imprint by the side of one side of a near external waviness component on the other hand at the time of press forming, and] increase of the external waviness component by the micro heterogeneous deformation of a steel plate. Moreover, the friction sliding friction at the time of press forming can be decreased to coincidence, and good workability can be acquired.
[0028] the description of this invention is carrying out optimal arrangement of the heights from which height's differs discretely on the front reverse side of a steel plate in consideration of the magnitude , height , arrangement spacing , and the rate of area , and is for the press forming nature of a steel plate to be boil markedly , and raise it , and mitigate an imprint operation of the wave to one side by processing of a field besides a steel plate also in processing order , and able to secure the outstanding paint image clarity .
[0029] It is advantageous, in order to obtain the steel plate of this invention, for example, if a detailed irregularity pattern is given to a reduction roll using the micro lithography method and a steel plate is rolled out and obtained using this reduction roll. As the approach is shown in drawing 1 , after irradiating the light of specific wavelength in the roll surface which applied the resist material exposed on specific wavelength, making it expose and developing negatives, a roll surface is etched by chemical etching or gas phase etching, and a detailed concavo-convex pattern is established by removing the hardening resist section. Thus, the cross section of the obtained steel plate is shown in drawing 3 . In addition, in P in drawing, the distance between heights peaks and D show the magnitude of a heights crowning, and t shows heights height, respectively.
[0030]
[Example] As shown in drawing 1 , the detailed concavo-convex pattern was given to the temper rolling roll (finishing roughness Ra 2.4micrometer) by the micro lithography method. Temper rolling was performed for the alloying processing hot-dip zinc-coated carbon steel sheet (0.8mm of board thickness) manufactured in usual continuation mold hot-dip-zincing Rhine at 1.0% of rolling reduction using the work roll. It is before and after processing about the obtained steel plate, and comparison investigation of paint image clarity and the sliding friction was conducted. In addition, each Ra of the crevice of a steel plate which manufactured in this way was in the range of about 0.25-0.80 micrometers.
[0031] After taking a photograph of the size (D) of the top face of the heights on the front face of a steel plate, and the rate of area of a crevice and spacing (P) of heights with the optical microscope, image-analysis equipment estimated them quantitatively and they calculated the average. Moreover, from the cross-section profile curve measured with the sensing-pin type roughness meter, heights height calculated the average of the peak height corresponding to steel plate heights. In addition, heights height was found by the difference of elevation from the average height of the crest part of the profile curve of the crevice of the heights circumference to a crevice peak location.
[0032] As a test method of paint image clarity, after performing paint of about 80 micrometers of

thickness to the above-mentioned steel plate after temper rolling, the "specular gloss measuring method" of JIS-Z8741 estimated paint image clarity. As an evaluation test method of friction sliding nature, the square shape bead testing device of the L character tension shown in drawing 2 R> 2 was used, and it pressed down with the tension tester, and asked for the relation between a load and a tensile load. Here, comparative evaluation is carried out not by coefficient of friction but by the presser-foot load (Pc) of the limitation which plate fracture produces, and frictional resistance can judge that it is few and sliding nature is good, so that this value of Pc is large. As a test condition, one sample offering steel plate was used for every presser-foot load, and after applying 1g (viscosity 6cst 40 degree C) /of slushing oil for the usual galvanized steel sheets two times m by coverage as the board width of 17mm, sliding die length of 250mm, and 500mm a part for /and the lubricating oil in tension rate, the trial was presented.
[0033] As the image clarity evaluation approach after processing, 750mm square shape punch performed deep drawing, and extruding was carried out with the punch shoulder radius of 100mm. In addition, the one side side of a steel plate was made into the evaluation side, and on the other hand, press working of sheet metal was carried out as a punch side, and in a part for the shoulder of the workpiece equivalent to the part in contact with punch, the side painted to the one side side which becomes the external surface side of a workpiece, and carried out comparative evaluation of the paint image clarity by the visual evaluation approach.
A visual score: (good) O-**-x (**)
A test result is shown in Table 1.
[0034] consequently, it is in ** that this invention boils markedly the steel plate manufactured by this invention in both sides of paint image clarity and sliding nature, and it is excellent since the example of a comparison of this invention and the paint image clarity before and behind processing are maintained by the high order and friction sliding nature is also maintained good.
[0035]
[Table 1]

表 1

番号	凸部サイズと配置間隔（片面側／他面側）			凹部の平均面積率（%）	塗装鮮鋭性 加工前（%） 片面側	塗装外観 加工後 (片面側)	摺動性 限界荷重 Pc／kgf	備考
	凸部径（Dμm）	凸部間隔（Pμm）	凸部高さ（tμm）					
1	10／25	50／50	2／3	96／80	92	○	250	本発明1
2	500／1000	2000／2200	5／8	95／81	88	○	190	本発明2
3	100／150	300／150	12／20	90／25	87	○	240	本発明3
4	100／200	200／300	7／10	80／65	83	○	240	本発明4
5	200／100	400／140	5／9	80／60	80	○	230	本発明5
1	8／20	16／30	3／3	80／65	85／89	×	180	比較例1
2	200／100	600／160	15／22	90／70	77／79	×	230	比較例2
3	1200／1500	2400／2000	7／15	80／50	80／45	×	170	比較例3
4	100／100	600／500	4／7	97／97	95／95	△	180	比較例4
5	500／500	2500／2300	2／4	97／96	92／92	△	220	比較例5

[0036]

[Effect of the Invention] When this invention limits the heights gestalt on the front face of a steel plate, and its arrangement distribution to the optimal range in respect of [of a front flesh side] each, the outstanding steel plate which also has the effectiveness of improving press-forming nature by reducing a sliding friction to the effectiveness of maintaining the paint image clarity in press-forming order to a high order, and coincidence is obtained.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] (a), (b), (c), and the (d) Fig. are an explanatory view showing an example of the concavo-convex grant processing process of this invention by the lithography method,
[Drawing 2] The mimetic diagram showing the testing device which measures the sliding friction of a steel plate,
[Drawing 3] It is the cross section of the steel plate obtained by this invention.
[Description of Notations]
1 Hopper
2 Liquefied Sensitization Resin
3 Ayr
4 Sensitization Resin Feeder
5 Photopolymer Layer
6 Laser Oscillation Machine
7 Laser
8 Slit
9 Chopper
10 10' Sensitization hard spot
11 Sprayer
12 Resolvent
13 Outcrop
14 Convex Type Bead
15 Steel Plate for Trial
16 Receptacle Mold Dice

[Translation done.]

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Ｂ２１Ｂ　1/22		Ｌ　7128－4Ｅ		
		Ｃ　7128－4Ｅ		

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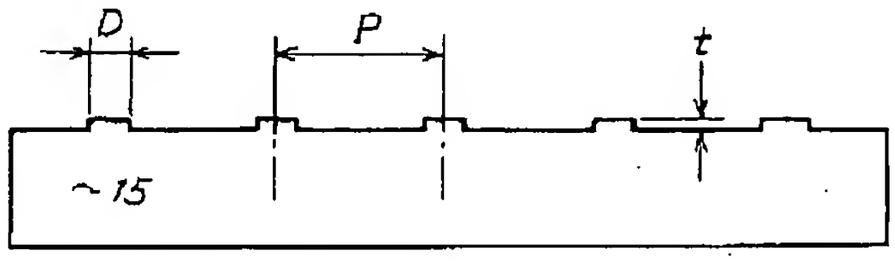
(54)【発明の名称】　塗装鮮映性とプレス加工性に優れた鋼板

(57)【要約】

【目的】　本発明は、塗装鮮映性とプレス加工性に優れた鋼板を提供する。

【構成】　鋼板の表裏両面に散在する凸部頂面の大きさが１０～１０００μｍ、凸部のピーク間距離が５０～２００μｍ、かつ鋼板の片面側の凹部の粗度Ｒａが０．８μｍ以下とし、鋼板片面側に散在する凸部頂点の高さが2～１２μｍ、他面側の凸部高さが３～２０μｍの範囲で片面側より高くし、かつ鋼板片面側の凹部平均面積率が７０～９６％とし、他面側の凹部平均面積率が片面側より小さくなるように凸部を離散分散させることを特徴とする表裏において異種プロフィルを有する鋼板。

【効果】　かくすることにより、プレス加工性を改善するとともに、加工後の塗装鮮映性の劣化を確実に防止できる。



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【特許請求の範囲】

【請求項１】　鋼板の表裏両面に散在する凸部頂面の大きさが１０～１０００μｍ、凸部のピーク間距離が５０～２２００μｍ、かつ鋼板の片面側の凹部の粗度Ｒａが０．８μｍ以下とし、鋼板片面側に散在する凸部頂点の高さが２～１２μｍ、他面側の凸部高さが３～２０μｍの範囲で片面側より高くし、かつ鋼板片面側の凹部平均面積率が７０～９６％とし、他面側の凹部平均面積率が片面側より小さくなるように凸部を離散分散させることを特徴とする塗装鮮映性とプレス加工性に優れた鋼板。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は自動車や家電製品の外板等に使用する鮮映性とプレス加工性に優れた鋼板類に関するものである。ここで鋼板類とは、塗装して使用する板状の製品を意味し、例えば熱延鋼板、冷延鋼板、表面処理鋼板（電気めっき鋼板、溶融めっき鋼板、合金化処理溶融めっき鋼板、蒸着めっき鋼板、溶融塩電解めっき鋼板など）などの鋼板の他に、例えばステンレス鋼板、アルミニウム板、銅板なども含むものである。

【０００２】

【従来の技術】一般に、自動車のボディーや家電製品の外板等に使用する鋼板はプレス成形を施すことにより製品として使用されるが、製品の高精度化と複雑化に伴い、鋼板類に対する要求が従来以上に高級化、多様化しつつあり、中でも最近は塗装鮮映性とプレス成形性に関する要求が高まっている。例えば、製品自体の鮮映性を向上させるには、塗装膜厚を厚くすることで確実に改善できるが、塗装費用が高くなる問題がある。このため塗装膜厚が薄くても塗装鮮映性を確保できる鋼板が強く望まれている。また現状では塗装鮮映性を確保するため、３回塗装や４回塗装が施されているが、省工程と塗装費用削減のため塗装回数を２または３回に省略することが強く望まれており、これを実現できる鋼板が強く望まれている。こうした要求に応えるために例えば、特開昭６３－１３２７０１号公報の如くレーザーを用いて圧延ロールに微小な凹凸を設け、その圧延ロールを用いて鋼板類を圧延し、塗装鮮映性に優れた鋼板を得ることが知られている。

【０００３】

【発明が解決しようとする課題】塗装鮮映性を向上させるには、鋼板の表面が平坦で鏡面に近いほど有利である。このため表面を細かくする方向で種々の提案がなされている。ただし単に鏡面化すると鋼板類の製造工程において、熱処理工程やめっき工程において疵が顕在化し易くまた、鋼板類の切断後のパイリングやプレス加工時に表面疵が発生し、表面欠陥となるため種々の工夫が提案されている。ところで製品を製造する際にはプレス加工が前提となるが、この場合に加工後表面外観改善のため砥石掛けされることがあり、このため砥石掛け模様が

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塗装後に浮き出る問題がある。またプレス加工により鋼板粗度が変化するため、加工度が厳しくなるほど鮮映性が劣化する問題がある。このため加工後も良好な塗装鮮映性を維持できる鋼板が強く望まれている。

【０００４】加工による塗装鮮映性の劣化の原因には、２種類がある。すなわち素材の結晶粒度が大きい場合に、変形の不均一が原因で粗度が変化してうねり成分が増加することに起因して塗装鮮映性が劣化する場合、もう一つはポンチと接触する他面側の粗度が高面圧によりその反対面である片面側に浮き出るために、片面側の塗装鮮映性が劣化する場合がある。いずれにしろ最近は高い鮮映性が要求されるため、このような加工後の塗装鮮映性の劣化の小さいことが強く望まれている。

【０００５】また最近では複雑な形状の部品をプレス加工することから、成形時の摺動性が良好であることが望まれている。とりわけ亜鉛めっき鋼板や合金化処理溶融亜鉛めっき鋼板などの表面処理鋼板は、高面圧下ではダイスとめっき層が凝着し易く、摩擦抵抗が増大するため、成形時に板破断し易くかつ成形適性範囲が狭い問題がある。本発明は、上述したような鮮映性鋼板に要求される品質課題に的確に応えるため、プレス成形時の摺動特性を改善し、かつプレス加工後も良好な鮮映性確保を確保できる鋼板類を提供しようとするものである。

【０００６】

【課題を解決するための手段】本発明は、鋼板の表裏両面において、散在する凸部頂面の大きさが１０～１０００μｍ、凸部ピーク間距離が５０～２２００μｍ、凹部の粗度Ｒａが０．８μｍ以下、かつ鋼板片面側の凹部の平均面積率が７０～９６％、鋼板他面側の凹部の平均面積率が片面側より小さくなるように凸部に離散分散させ、かつ鋼板片面側に散在する凸部頂点の高かさが２～１２μｍの範囲により、鋼板他面側の凸部高さが３～２０μｍの範囲で片面側より高くすることを特徴とする塗装鮮映性とプレス加工性に優れた鋼板を提供するものである。すなわち、本発明は表裏で異なる粗度プロフィルを付与することで、プレス成形時の摺動性を改善すると同時に、プレス成形後も良好な塗装鮮映性を確保することを特徴とするものである。

【０００７】本発明の粗度プロフィルの形態に関して次に詳細に説明する。我々は加工前後においても良好な塗装鮮映性を維持し、かつプレス成形性を格段に改善するための粗度プロフィルの条件について種々検討した結果、次に述べるように、鋼板表面の大部分を占有する平坦な凹部と、離散的に散在する微少な凸部からなる粗度プロフィルを最適に構成することが重要であり、かつ確実に改善できることを見いだした。

【０００８】特に最近では、過酷なプレス成形性が要求されるため、一層の成形性改善が望まれており、塗装鮮映性とプレス加工性の両者を改善しうる最適な鋼板表面の構造について検討した結果、本発明に到達した。加工

しなければ問題はないが、加工すると従来技術では塗装鮮映性が劣化する問題がある。プレス加工後も良好な塗装鮮映性を確保するためには、鋼板の表裏においてプレス成形時に内面側となる他面の凸部の高さを、外面となる片面側の凸部高さより高くし、かつ片面側の凹部平均面積率を７０～９６％とし、他面側の凹部平均面積率を片面側より小さくすることで解決できることを見いだした。

【０００９】次に本発明の要点を、鋼板片面側と他面側とに関して順次説明することとし、まずは片面側に関して述べる。鋼板の片面側は製品となった場合に、人の目に直接ふれる外面側となることから、塗装の仕上がり性、中でも塗装鮮映性が重要品質となる。塗装鮮映性は鋼板凹部の粗度と面積率に関係する。したがって、凹部の粗度としては極力平坦で鏡面に近いことが望ましいが、工業的に有利に製造するにはＲａで０．８μｍ以下であれば塗装鮮映性を充分確保でき満足しうるものである。また凹部の面積率は高いほど塗装鮮映性向上に有利であるが、凹部面積率が７０～９６％範囲で確保することが望ましい。凹部面積率が７０％より小さいと凹部の粗度を改善しても、鮮映性を確保することが困難となる。また逆に９６％より大きいと鮮映性は良好であるが、耐疵性やプレス時の摺動性が劣化するため好ましくない。一方、加工後の塗装鮮映性は７０％より小さくても、９６％より大きくても劣化するため上記範囲が最適である。

【００１０】一方、凸部の形態に関しては、凸部頂部の大きさは１０～１０００μｍとし、成形部品の外面となる鋼板片面側の凸部高さが２～１２μｍにする必要がある。凸部の大きさが、１０μｍより小さいと成形した時にポンチ荷重により容易に潰されることは少なくなるが、ポンチとの接触面積率が増加して摺動性が劣化する。また加工工程や搬送工程において、鋼板表面や塗膜表面に擦り傷が目立ち易くなる問題がある上に、良好な塗装鮮映性を確保できなくなる問題がある。

【００１１】また凸部の高さに関しては、２μｍより低いと成形時に容易に潰されるため、摺動性が劣化すること、および加工工程や搬送工程において、擦り傷が付き易くなるため凸部に必要とされる機能が発揮されなくなる。逆に１２μｍより高くすると、摺動性や擦り疵性は改善されるが、塗装後に凸部が浮きでて塗装鮮映性が劣化する問題が起こる。

【００１２】次に加工時にポンチが接触する鋼板他面側に関して本発明の要点を説明する。鋼板の他面側は人の目には直接ふれない製品の内面側となることから、塗装鮮映性は最重要な品質ではなく、むしろ加工時のポンチとの摺動性を良好に維持し、かつ加工後の片面側の塗装鮮映性が劣化するのを極力抑制できることが重要である。摺動性を確保するには、前述したように高面圧下においても凸部の潰れを抑制した上で、ダイスとの接触面積率を極力小さくすることが重要である。このため、他の品質を劣化させない条件範囲で凸部の高さを大きくし、かつ凸部の面積率を適正化することが望ましい。この観点から、種々検討した結果、成形部品の内面となる鋼板他面側の凸部高さは３～２０μｍの範囲で片面側より高くすること、また凹部面積率を片面側より小さくすることで、他面側に必要とされる作用が発揮できることが判明した。

【００１３】さらに詳しく説明すると、他面側の凸部の頂部の大きさは、前述した片面側と同様の理由により１０～１０００μｍが望ましい。一方、凸部の高さは摺動性向上作用と加工による片面側の鮮映性の劣化を抑制する作用の２点から、３～２０μｍが望ましく、３μｍより低いと凸部が容易に潰れて、摺動性改善作用がなく、かつ鋼板他面のうねりが片面側に転写されるため、片面側の塗装鮮映性が劣化する問題がある。逆に２０μｍより高いと、摺動性は十分良好に保持されるが、加工後に反対面である片面側に他面の凸部のパターンが転写されるため、片面側の塗装鮮映性を劣化させることになり好ましくない。

【００１４】次に加工による塗装鮮映性劣化の観点から詳細に述べる。熱間圧延、冷間圧延、調質圧延など種々の圧延を得て板厚制御、材質制御、形状制御が行われるのが普通である。このため種々のロールによる粗度プロフィルが鋼板表面に転写されているため、種々の波長の粗度のうねり成分が存在する。このうねり成分を除去することは工業的に種々の困難が伴う上にコスト的に安価な方法で改善できない問題がある。

【００１５】プレス加工により鮮映性が劣化するのは、次の２つの理由による。１つは鋼板を加工すると、素地結晶粒が変形して進行するが、その際に材料のミクロ的な不均一変形に起因して「うねり」が増大することに起因するもの、もう１つは、ポンチによる押し出し加工時に裏面の粗度が反対面に転写されることにより「うねり」が増大することに起因するものである。すなわち後者の事例は、プレス成形すると平滑な表面を有するポンチにより他面側から高圧下されると、他面側のうねり成分が片面側に押し出されることになり、片面側の粗度のうねり成分が増大し、塗装鮮映性が劣化するものである。いずれにしろここでは、これらの問題を「加工によるうねりの増大」と呼ぶこととする。

【００１６】我々はこれら問題の解決方法について種々検討した結果、ポンチと接触する他面側の凸部を高くし、かつ他面側の凹部面積率を片面側より小さくすることで「加工によるうねりの増大」が回避できることを見いだした。同時にこの凸部がポンチやダイスとのミクロ的な真実接触面積率を低下させる効果を有するため、高面圧での摩擦抵抗が減少し、プレス成形時の摺動性を改善し、成形適性範囲が拡大する有利な点がある。また摺動性が改善されて、材料の均一変形性が向上するため、

素材の結晶粒に起因する問題点も改善される作用がある。

【0017】この問題を回避するために、凸部面積率を高めたり、凸部の頂面の大きさを増加させることなどが考えられるが、いずれも摺動抵抗を高めたり、「加工によるうねりの増大」の防止効果はないか、または逆に劣化させたりするため有効ではない。我々は種々検討した結果、鋼板の片面側は本発明範囲とした上で、成形部品の内面側となる鋼板他面側の凸部高さを3～20μm範囲で片面側より高くし、かつ他面側の凹部面積率を片面側より小さくすることで、「加工によるうねりの増大」による塗装鮮映性の劣化が抑制できる作用があることを見いだした。その理由について次に述べる。

【0018】鋼板の他面側は塗装鮮映性は問題でなく、むしろ成形時の摺動性の確保とプレス加工後の粗度変化による鮮映性の劣化を抑制するために重要である。すなわち、プレス成形時にビード部分やしわ押さえ部分では、高面圧下で摺動を伴う加工を受けるため、ダイスと鋼板表面との摩擦抵抗が増大し、摺動性が劣化したり、表面処理鋼板の場合にはめっき層が剥離したりする問題がある。この問題を回避するには、ダイスと鋼板表面とのミクロ的な接触表面積率を低減することが重要で、高圧下状態において摺動性を確保するには、凸部高さを3μm以上で20μm以下とし、かつ他面側の凹部面積率を片面側より小さくすることが望ましい。

【0019】すなわち、片面側は塗装鮮映性が重要のため凹部面積率を70～96%に確保することが重要であるが、他面側はむしろ加工時に良好な特性を保持することが重要である。すなわち、他面側に要求される特性は、成形時に他面側の凸部が潰れ難いことが重要である。他面側の凸部が成形時に容易に潰されると、2つの問題、すなわち1つは、ポンチと鋼板の真実接触面積率が増加するため、摺動性が劣化すること、もう1つは他面側の粗度が反対面である片面側に転写され易くなり、片面側のうねりが増大して、塗装鮮映性が劣化するなどの問題がある。

【0020】このように他面側に必要な機能は、加工時におけるポンチとの良好な摺動性確保および片面側の塗装鮮映性の劣化を極力低減することにある。このように、鋼板表裏における機能分担を種々の観点から検討した結果、本発明に到達した。鋼板他面側の凸部が成形時に潰れ難くするには、凸部1個にかかる面圧を小さくすること、かつ凸部の高さを極力高くする必要がある。こうした理由により、他面側の凸部を3～20μm範囲で片面側より高くし、かつ凸部面積率を確保するために、凹部面積率を片面側より小さくすることで、他面側に必要とされる作用を発揮できる。またこのような粗度プロフィルを有する本発明は、鋼板素地の結晶粒の変形に起因するミクロ的な不均一変形による塗装鮮映性の劣化も軽減する効果があり、有利な作用を有する。

【0021】ところで凸部の配置としては、加工時のダイス・ポンチによる高面圧に耐えるためには、極力その面積率を高める必要がある。したがって、他面側の凹部面積率は、片面側のそれよりも小さくする必要があり、かつ凸部は50～2200μmの間隔で離散的に配置することが望ましい。他面側の凹部平均面積率は他面側より小さくすれば良いが、例えば凹部面積率として25～90%であればより好ましい。25%より小さいと凸部の面積率が大き過ぎるため、ポンチとの接触面積率が増加して摺動性が劣化する。また90%より大きいと凸部の面積率が低下するため、過酷な成形を行った場合に、凸部1個あたりの面圧が増大し、潰され易くなるため凸部による摺動性改善作用が低下する。

【0022】ところで、凸部の配置の間隔に関しては、50μmより小さくしても摺動性や加工による粗度転写性に対する改善効果が飽和するのに対して、凸部を付与する加工コストが増加するため好ましくない。また2200μmより大きくすると、頂部の間隔が大きすぎるため、凹部に擦り傷が入り易い問題があること、また加工時に1個の凸部にかかる面圧が高くなるため、反対面である片面側に凸部の模様が浮き出易くなり塗装鮮映性が劣化する問題がある。したがって、凸部の頂部間隔は50～2200μmが望ましく、本発明の作用を有効に発揮できる。

【0023】なお、鋼板他面側の凹部面積率を片面側より小さくする他の重要な作用について次に述べる。本発明の鋼板を工業的に安価に製造するには、ロールに凹凸パターンを設け、当該ロールにより冷間圧延したり、調質圧延したりして、凹凸を転写して製造することが一般的であり、有利かつ簡便な方法である。この方法の場合、ロールの凸部で鋼板表面を圧下し、鋼板の凹部を形成することになる。ところが、一般に知られている調質圧延に本発明を適用した場合には、板の形状や材質特性を制御する必要から、鋼板の圧下による鋼板伸び率が0．5～2．0%に規制される場合が多く、圧下率が小さいため、鋼板の凹部の面積率の増加とともに鋼板の凸部高さが減少する問題がある。

【0024】これは、ロール圧下による鋼板の伸び率は、近似的に下式で表される。

$$\Delta L = \Delta t \times S$$

（ここでΔL：鋼板伸び率、S：凹部平均面積率、Δt：板厚平均減少率）

このため、所定の鋼板伸び率：ΔLを得るのに対して、鋼板凹部の面積率：Sの増加とともに、平均板厚減少率：Δtが小さくなるため、結果として圧下の小さい鋼板凸部と圧下された凹部との段差、すなわち凸部高さが小さくなることになる。

【0025】したがって、凸部高さを極力高くするには、凹部面積率を小さくすることが望ましい。しかし、鋼板の他面側は塗装鮮映性確保の観点から、凹面積率を

７０～９６％と高くする必要があるため、鋼板他面側の凹部面積を片面側より小さくすることで凸部高さを高くすることができる。鋼板他面側の凹部面積率が小さいほど、鋼板他面側および片面側の凸部は高くなる作用があるが、鋼板他面側の凹部面積率は上述したように２５～９０％で、かつ片面側より小さくすることで、本発明の鋼板が得られる。

【００２６】以上に述べたように、鋼板他面側の凹部面積率を片面側より小さくすることで、本発明の凸部高さを確実にうることができること、また、鋼板の表裏で粗度プロフィルの機能分担をさせ、それぞれの面に必要とされる条件に最適化することで、本発明の作用（摺動性向上および加工前後での塗装鮮映性の確保）を確実に発揮できることが本発明の特徴である。

【００２７】上述したように、鋼板表裏の機能分担と最適化を図ることを目的に、種々の観点から粗度プロフィルを基礎的に検討した結果、本発明に到達した。すなわち、プレス成形時に他面側のうねり成分の片面側への転写を抑制すること、また鋼板のミクロ的な不均一変形によるうねり成分の増大を抑制することの２つの作用により、加工後も片面側の塗装鮮映性を良好に維持することができる。また同時にプレス成形時の摩擦摺動抵抗を減少させ、良好な加工性を得ることができる。

【００２８】本発明の特徴は、鋼板の表裏で高さの異なる凸部をその大きさ、高さ、配置間隔、面積率を考慮して離散的に最適配置することで、鋼板のプレス成形性を格段に向上させ、かつ加工前後においても鋼板他面の加工による片面へのうねりの転写作用を軽減し、優れた塗装鮮映性を確保できることにある。

【００２９】本発明の鋼板を得るには、例えばマイクロリソグラフィー法を用いて圧延ロールに微細凹凸模様をつけ、該圧延ロールを用いて鋼板を圧延して得ると有利である。その方法を図１に示す如く、特定の波長で感光するレジスト材を塗布したロール表面に特定波長の光を照射し感光させ、現像した後、化学的エッチングもしくは気相エッチングによってロール表面をエッチングし、硬化レジスト部を除去することによって微細な凹凸模様を設けるようにするものである。このようにして得られた鋼板の断面模式図を図３に示す。なお、図中のＰは凸部ピーク間距離、Ｄは凸部頂部の大きさ、ｔは凸部高さをそれぞれ示す。

【００３０】

【実施例】図１に示すように、調質圧延ロール（仕上げ粗度Ｒａ　２．４μｍ）にマイクロリソグラフィー法により微細な凹凸模様をつけた。そのワークロールを用いて、通常の連続型溶融亜鉛めっきラインで製造した合金化処理溶融亜鉛めっき鋼板（板厚０．８ｍｍ）を圧下率１．０％で調質圧延を行った。得られた鋼板について加工前後で塗装鮮映性、摺動抵抗を比較調査した。なお、こうして製造した鋼板の凹部のＲａはいずれも約０．２５～０．８０μｍの範囲にあった。

【００３１】鋼板表面の凸部の頂面のサイズ（Ｄ）や凹部の面積率および凸部の間隔（Ｐ）は、光学顕微鏡により写真撮影してから、画像解析装置により定量的に評価しその平均値を求めた。また凸部高さは触針式粗度計により測定した断面プロフィル曲線から、鋼板凸部に対応したピーク高さの平均値を求めた。なお凸部高さは、凸部周辺の凹部のプロフィル曲線の山部分の平均高さから凹部ピーク位置までの高低差で求めた。

【００３２】塗装鮮映性の試験方法としては、調質圧延後の上記鋼板に膜厚約８０μｍの塗装を施した後、ＪＩＳ－Ｚ８７４１の「鏡面光沢度測定法」により塗装鮮映性を評価した。摩擦摺動性の評価試験方法としては、図２に示すＬ字引張りの角型ビード試験装置を使用し、引張り試験機により押さえ荷重と引張り荷重の関係を求めた。ここでは摩擦係数でなく、板破断が生ずる限界の押え荷重（Ｐｃ）で比較評価し、このＰｃの値が大きいほど摩擦抵抗が少なく摺動性が良好と判断できる。試験条件としては、各押さえ荷重毎に１本の供試鋼板を使用し、その板巾１７ｍｍ、摺動長さ２５０ｍｍ、引張り速度５００ｍｍ／分、潤滑油として通常の亜鉛めっき鋼板用の防錆油（粘度６ｃｓｔ　４０℃）を塗布量で１ｇ／m^2塗布してから試験に供した。

【００３３】加工後の鮮映性評価方法としては、７５０ｍｍ角型ポンチで深絞り加工を行い、ポンチ肩半径１００ｍｍにより押し出し加工した。なお、鋼板の片面側を評価面とし、他面側がポンチ側としてプレス加工し、ポンチと接触する部分に相当する加工品の肩部分において、加工品の外面側となる片面側に塗装を施し、塗装鮮映性を目視評価方法により比較評価した。

目視評点：（良）○－△－×（劣）

試験結果を表１に示す。

【００３４】この結果、本発明により製造された鋼板は、本発明の比較例および加工前後における塗装鮮映性が高位に維持されておりかつ、摩擦摺動性も良好に維持されていることから、本発明が塗装鮮映性と摺動性の両面において格段に優れていることが明かである。

【００３５】

【表１】

表 1

番号	凸部サイズと配置間隔（片面側／他面側） 凸部径（Dμm）	凸部間隔（Pμm）	凸部高さ（tμm）	凹部の平均面積率（%）	塗装鮮鋭性 加工前 片面側（%）	塗装外観 加工後（片面側）	摺動性 限界荷重 Pc／kgf	備考
1	10／25	50／50	2／3	96／80	92	○	250	本発明1
2	500／1000	2000／2200	5／8	95／81	88	○	190	本発明2
3	100／150	300／150	12／20	90／25	87	○	240	本発明3
4	100／200	200／300	7／10	80／65	83	○	240	本発明4
5	200／100	400／140	5／9	80／60	80	○	230	本発明5
1	8／20	16／30	3／3	80／65	85／89	×	180	比較例1
2	200／100	600／160	15／22	90／70	77／79	×	230	比較例2
3	1200／1500	2400／2000	7／15	80／50	80／45	×	170	比較例3
4	100／100	600／500	4／7	97／97	95／95	△	180	比較例4
5	500／500	2500／2300	2／4	97／96	92／92	△	220	比較例5

【００３６】

【発明の効果】本発明は鋼板表面の凸部形態およびその配置分布を表裏の各々の面で最適範囲に限定することにより、プレス成形前後での塗装鮮映性を高位に維持する効果と同時に、摺動抵抗を低減することでプレス成形性を改善する効果も有する優れた鋼板が得られるものである。

【図面の簡単な説明】

【図１】（ａ）、（ｂ）、（ｃ）および（ｄ）図はリソグラフィー法による本発明の凹凸付与加工工程の一例を示す説明図、

【図２】鋼板の摺動抵抗を測定する試験装置を示す模式図、

【図３】本発明により得られた鋼板の断面模式図である。

【符号の説明】

1　ホッパー
2　液状感光樹脂
3　エアー
4　感光樹脂供給器
5　感光性樹脂層
6　レーザー発振器

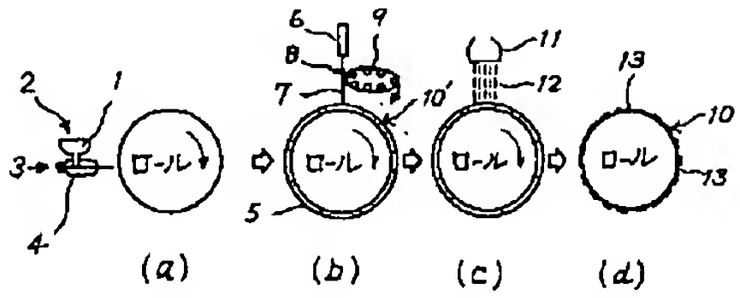
11

7　レーザー
8　スリット
9　チョッパー
10、10´　感光硬化部
11　噴霧器

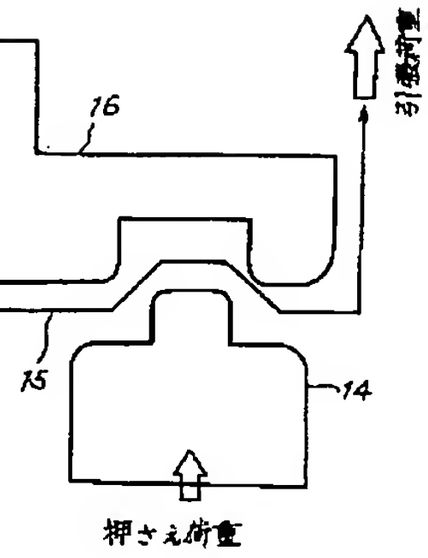
12

12　溶解剤
13　露出部
14　凸型ビード
15　試験用鋼板
16　受け型ダイス

【図1】



【図2】



【図3】